TECHNICAL REPORT ARBRL-TR-02413

120MM GUN HEAT INPUT MEASUREMENTS

Timothy L. Brosseau
Irvin C. Stobie
J. Richard Ward
Robert W. Geene

July 1982

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
BALLISTIC RESEARCH LABORATORY
ABERDEEN PROVING GROUND, MARYLAND

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Gun barrel wear
Ablative coolant
Wear-reducing additives
XM256 Gun

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) (raj)

Imbedded thermocouples just beyond the engraving region have been used to measure total heat input in guns. The method has been applied to the XM256 cannon to estimate erosion. Rounds were fired with JA2, M30, M6, and M1 propellants with various charge to mass ratios. Efforts were made to measure total heat input without the combustible case. Total heat input was reduced from 387 J/mm to 247 J/mm in a series of rounds with 0.3 kg silicone ablative as a wear-reducing additive.

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I. INTRODUCTION

Heat input measurements over the past several years in the M68 tank cannon have aided in understanding how additives such as TiO_2-wax reduce gun wear.[1-3]

The Army has just started development of a German 120-mm smoothbore, chrome-plated cannon for the M1 tank[4], so there is little information on gun wear in the 120-mm gun (denoted the XM256 cannon). An opportunity arose recently at the BRL to make heat input measurements in the XM256 cannon during experiments to design a "super-slug" round which will test the recoil system's durability. The heat input measurements may be used later to correlate gun wear with heat input as wear data are collected. Firings were also made without the combustible case and with ablative coolant from Calspan Corp.[5]

II. EXPERIMENTAL

Heat transfer measurements were made in the XM256 gun, RP14, that had previously fired 24 rounds. Heat input was measured with four 0.13-mm diameter constantan wires located 615 mm from the rear face of the tube (RFT). The thermocouples were spot-welded to the gun at various distances from the bore surface as depicted in Figure 1. Since the exact positions of the thermocouples from the bore surface are important in determining the total heat input, the problem of nonconcentricity of the bore of the gun tube was surmounted by drilling a small pilot hole to the bore surface. This pilot hole was viewed as a possible area of preferential chrome stripping in this gun tube. Figure 2 is a view of one of the pilot holes after 90 rounds. There appears to be no sign of chrome chipping, hence, Brosseau's technique is applicable for chromium-plated as well as steel gun tubes.

Brosseau[6] described how total heat input is computed from the temperature rise 100 ms after propellant ignition.

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[1] *T.L. Brosseau and J.R. Ward, "Reduction of Heat Transfer in 105mm Tank Gun by Wear-Reducing Additives," BRL Memorandum Report No. 2698, November 1976. (AD B015308L)*

[2] *T.L. Brosseau and J.R. Ward, "Measurements of Heat Input into the 105mm M68 Tank Cannon Firing Rounds Equipped with Wear-Reducing Additives," BRL Technical Report No. 02056, April 1978. (AD A056368)*

[3] *I.C. Stobie, T.L. Brosseau, and R.P. Kaste, "Heat Transfer Measurements in the 105mm M68 Tank Gun with M735 Rounds," BRL Technical Report No. 02265, September 1980. (AD A092351).*

[4] *A. Albright, "Overview of the Tank Main Armament System," Proceedings of the 1980 JANNAF Propulsion Meeting, CPIA Publication 315, March 1980.*

[5] *F.A. Vassallo, "An Evaluation of Heat Transfer and Erosion in the 155mm M185 Cannon," Calspan Technical Report VL-5337-D-1, July 1976.*

[6] *T.L. Brosseau, "An Experimental Method of Accurately Determining the Temperature Distribution and Heat Transferred in Gun Barrels," BRL Technical Report No. 1740, September 1974. (AD B000171L)*

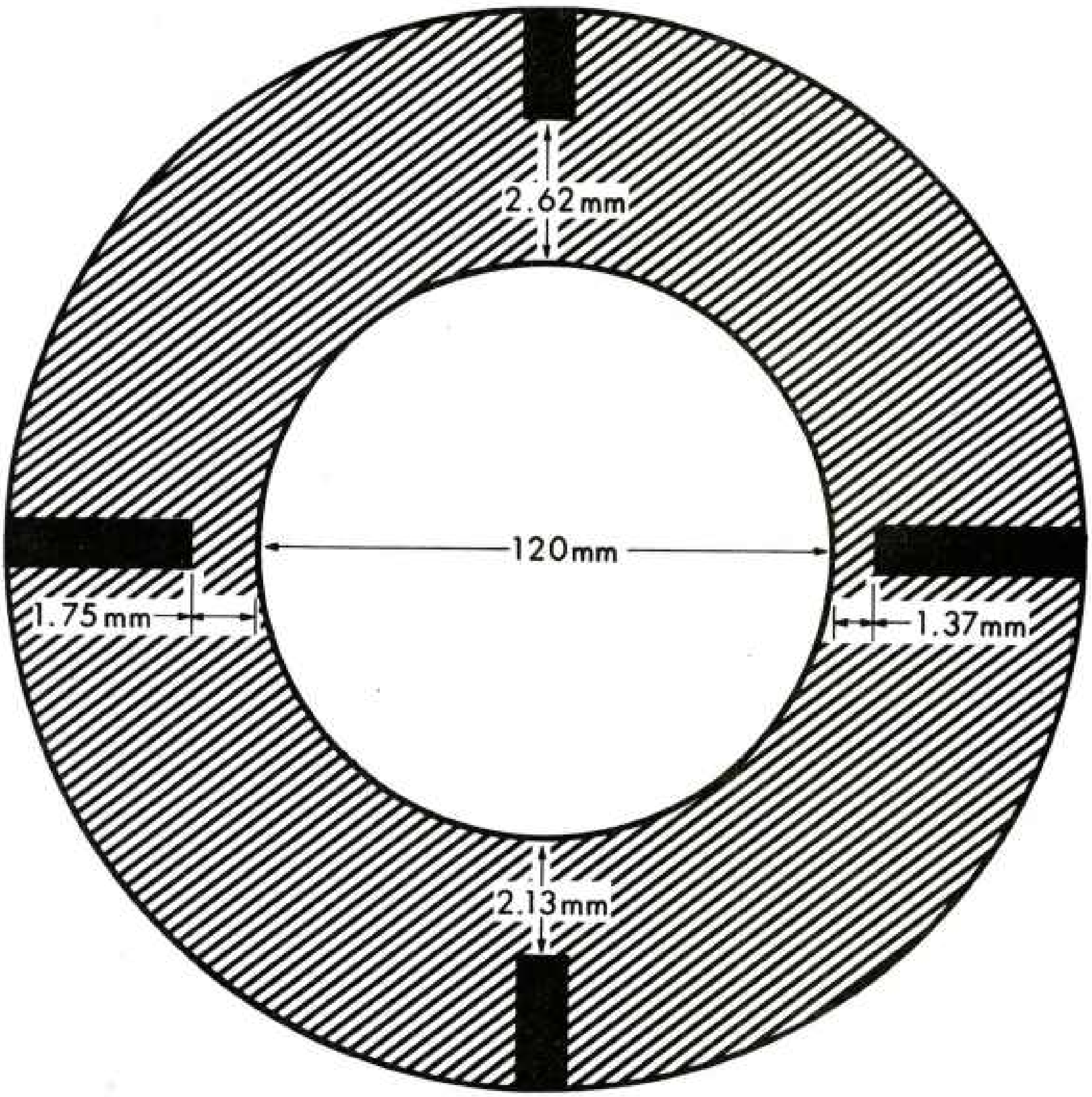

Figure 1. Radial Location of Thermocouples in 120mm Cannon at 615mm RFT

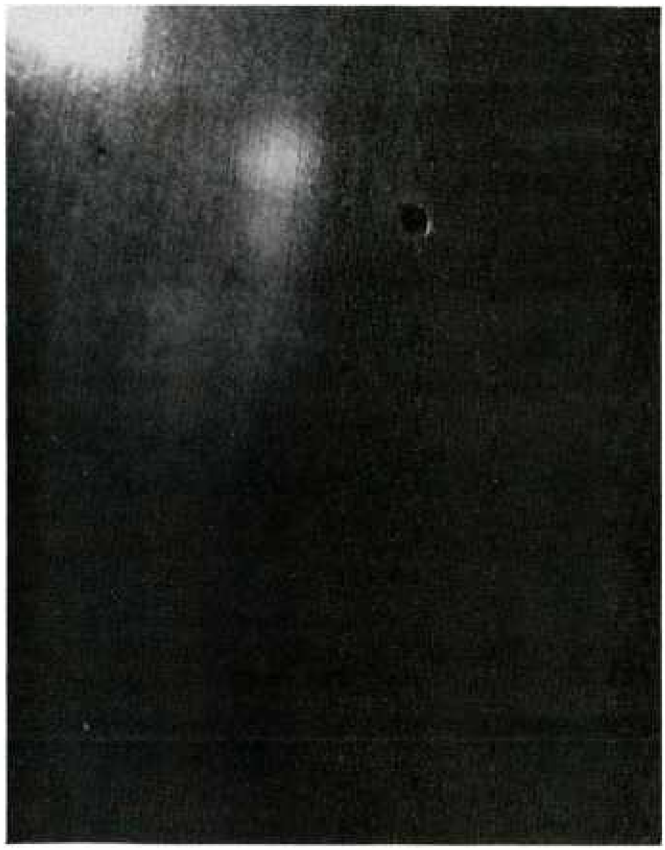

Figure 2. Pilot Hole for Imbedded Thermocouple 3 O'clock Position After 90 Rounds

Figure 3 illustrates the "super-slug" round fired during this test program and the placement of the ablative coolant in the round.

III. RESULTS AND DISCUSSION

Heat transfer measurements were made on nearly half the rounds fired. For replicate conditions without ablative coolant, the individual temperature rises at 100 ms were averaged to yield an average heat input. Heat inputs were computed for each round with ablative coolant.

Table 1 collects the heat inputs for rounds fired without ablative coolant. Relative erosivity of various propellants can be inferred from total heat input only when the interior ballistic cycles are identical. As one can see from Table 1, the different propellants did not have the match needed to make judgements on relative erosivity. The differences in heat input shown in Table 1 relative to ballistic performance are consistent with differences measured in steel gun tubes. Again, this implies Brosseau's method is applicable in chromium-plated tubes.

One observes in Table 1 that heat input increases when the combustible case is removed from the cartridge which might suggest that the combustible case insulates the barrel. The reduced ballistic performance from removing the combustible case makes it impossible to deduce anything about the insulating property of the combustible from this experiment alone.

Several groups of rounds were fired with ablative coolant supplied by Calspan Corp. Approximately 0.3 kg of ablative in a polyethylene container was mounted in the super-slug round between the washer and case cap (Figure 3). The results of the firings with the ablative coolant are listed in Table 2. The firings are grouped where propellant mass, projectile mass, and conditioning temperature are equivalent. Groups ID 59-65 and 107-115 are of particular interest, since rounds without additive preceded these rounds with ablative. Heat input for rounds without ablative are also available (Table 1-ID 29, 33, 36, and 37) for series ID-59-65. One sees a steadily decreasing heat input as ablative rounds are fired repeatedly (Figure 4).

In reference 2, Brosseau showed there was a cumulative heat transfer reduction when TiO_2-wax rounds were fired repeatedly. This cumulative effect with the ablative coolant was demonstrated by Vassallo in a 60mm gun.[7] Brosseau[2] noted that thirteen TiO_2-wax rounds were needed to reach a steady heat input with M392 cartridges. The data in Figure 4 suggest seven ablative rounds reach a minimum level of heat imput.

A notable exception to the progressive heat input reduction for ablative rounds occurs with the 6.8 kg M30 cartridge (ID 75-79) where the heat input increases as rounds are fired. It is likely that the ablative coolant is ineffective in this round, and rounds (ID 75-79) are removing the insulating layer deposited by rounds ID 59-74.

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[7] *F.A. Vassallo, "Thermal and Erosion Phenomenology in Medium-Caliber, Anti-Armor Automatic Cannons (MC-AAAC)," Proceedings of the 1980 JANNAF Propulsion Meeting, CPIA Publication 315, March 1980.*

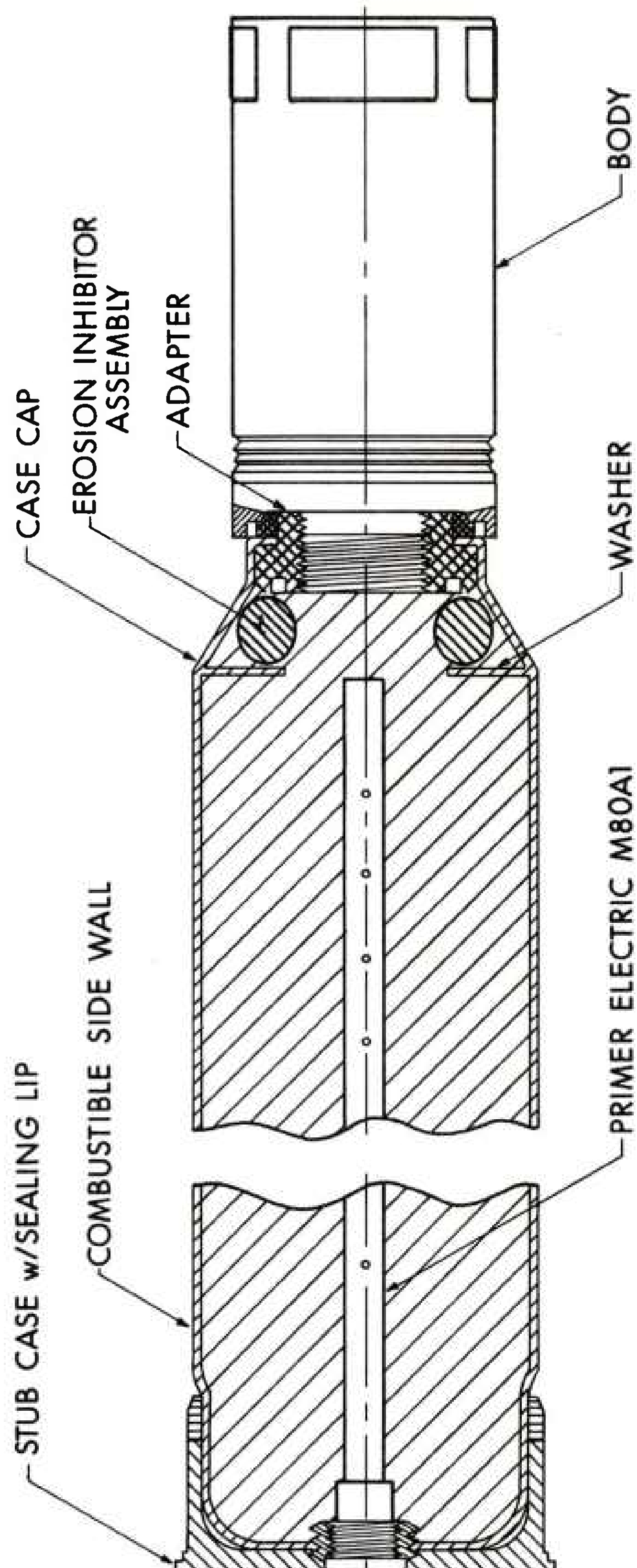

Figure 3. Super-Slug Round with Silicone Ablative Erosion Inhibitor

TABLE 1. 120 MM HEAT INPUTS WITHOUT ABLATIVE ADDITIVE

Idents	Propellant Mass, kg	Projectile Mass, kg	Pressure, MPa	Velocity, m/s	Heat Input, J/mm	Remarks
29,33,36,37	M30 - 8.2	13.1	623	1383	387.2	
55,58	JA2 - 7.2	13.1	692	1367	411.5	
93-95	M30 - 8.0	13.1	591	1346	331.0	
96-98	M30 - 8.0	13.1	433	1253	384.1	No Combustible Case
99	M6 - 6.8	5.5	204	1280	295.8	
103	M30 - 8.2	5.5	354	1558	361.4	
104-106	M30 - 8.8	5.5	384	1580	406.9	
122-128	M1 - 6.6	5.5	501	1623	252.0	

TABLE 2. HEAT INPUTS FOR ROUNDS WITH 0.3 kg ABLATIVE COOLANT

Idents	Rd No.	Propellant Mass, kg	Projectile Mass, kg	Pressure, MPa	Velocity, m/s	Heat Input, J/mm
59	42	M30 - 8.2	13.1	654	1391	351.6
60	43	M30 - 8.2	13.1	655	1391	290.1
62	44	M30 - 8.2	13.1	640	1376	267.9
65	45	M30 - 8.2	13.1	655	1388	247.3
66	46	M30 - 8.0	13.1	611	1358	260.7
69	47	M30 - 8.0	13.1	614	1366	249.9
71	48	M30 - 8.0	13.1	618	1363	211.7
72	49	M30 - 8.0	13.1	618	1355	203.4
74	50	M30 - 8.0	13.1	633	1351	186.9
75	51	M30 - 6.8	13.1	422	1198	185.3
76	52	M30 - 6.8	13.1	431	1190	185.3
77	53	M30 - 6.8	13.1	420	1190	193.1
78	54	M30 - 6.8	13.1	414	1188	222.0
79	55	M30 - 6.8	13.1	424	1198	278.3
80*	56	M30 - 8.0	13.1	700	1381	375.9
87*	57	M30 - 8.0	13.1	694	1375	225.1
83*	58	M30 - 8.0	13.1	689	1383	351.1
84*	59	M30 - 8.0	13.1	710	1376	269.0
85*	60	M30 - 8.0	13.1	694	1381	235.4
90	62	M30 - 4.9	13.1	216	934	233.9
91	63	M30 - 2.9	13.1	113	673	225.1
92	64	M30 - 2.9	13.1	113	680	207.6
107	77	M30 - 8.0	13.0	651	1380	332.0
108	78	M30 - 8.0	13.0	643	1378	277.8
109	79	M30 - 8.0	13.0	655	1360	272.8
110	80	M30 - 8.0	13.0	681	1366	237.5
111	81	M30 - 8.0	13.0	659	1368	210.7
112	82	M30 - 8.0	13.0	653	1376	209.1
113	83	M30 - 8.0	13.0	657	1370	174.5
114	84	M30 - 8.0	13.0	645	1368	179.2
115	85	M30 - 8.0	13.0	669	----	178.1

Initial temperature of rounds 306K.

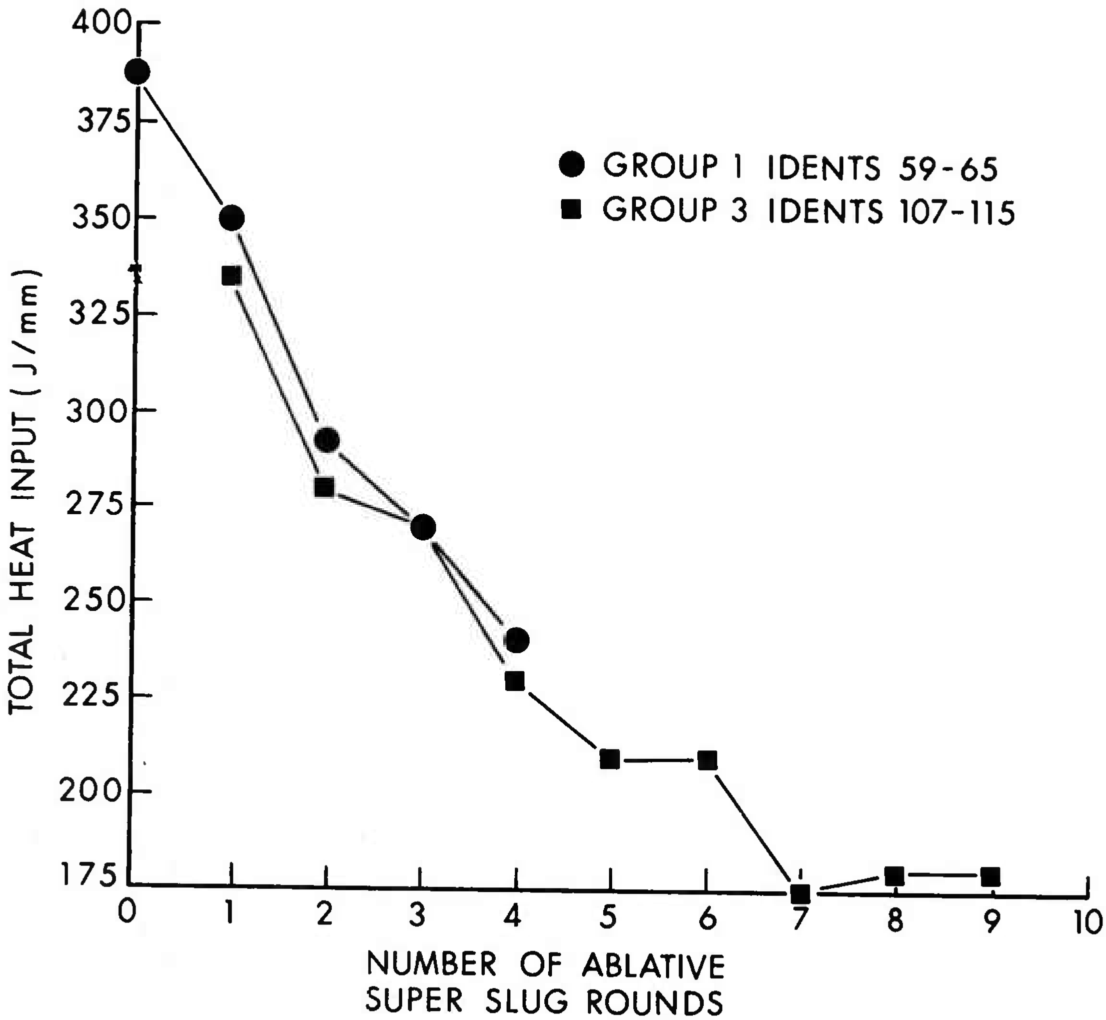

Figure 4. Cumulative Effect of Wear Reducing Additive (120mm Gun)

The temperature measurements used to compute total heat inputs are reflected in Appendix A. The normal method of assessing remaining life in gun tubes involves monitoring the bore diameter in the shot-start region.[8] In chromium-plated barrels such measurements may not be appropriate for predicting wear life because chromium plate stripped from the bore near the muzzle affects the accuracy of armor-piercing, discarding-sabot projectiles.[9]

From the inspection sheets in Appendix B, one can see there was no appreciable wear in the shot-start region.* There appears to be chromium flaking or stripping downbore, however. Only subsequent testing with the saboted projectiles will tell whether this will affect the useful life of the XM256 cannon.

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[8] *"Evaluation of Cannon Tubes," US Army Technical Manual TM-9-1000-202-14, November 1976.*

[9] *J.A. Lannon et al, "Performance of Chromium-Plate in the 105mm M68 Tank Cannon," Report in preparation.*

* *Commencement of full-bore is 23.80 inches RFT or 0.6045m RFT.*

IV. CONCLUSIONS

1. The ablative coolant packaged in the "super-slug" round produces significant reduction in heat input. The ablative coolant has a cumulative effect as repeated rounds are fired with coolant. The heat input reaches a minimum after seven rounds in this test as compared to thirteen rounds for TiO_2-wax additive in the M392A2 cartridge fired from the 105-mm M68 cannon.

2. Reducing the propellant charge in the "super-slug" round negates the ablative coolant's effectiveness in the reduction of total heat input.

3. The general trend in heat input with propellant and ballistic parameters in the chromium-plated 120-mm gun are consistent with trends seen in steel gun tubes. It seems that Brosseau's technique for measuring heat input is applicable in chromium-plated as well as steel tubes.

REFERENCES

1. T. L. Brosseau and J. R. Ward, "Reduction of Heat Transfer in 105mm Tank Gun by Wear-Reducing Additives," BRL Memorandum Report No. 2698, November 1976. (AD B015308L)

2. T. L. Brosseau and J. R. Ward, "Measurements of Heat input into the 105mm M68 Tank Cannon Firing Rounds Equipped with Wear-Reducing Additives," BRL Technical Report 02056, April 1978. (AD A056368)

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4. A. Albright, "Overview of the Tank Main Armament System," Proceedings of the 1980 JANNAF Propulsion Meeting, CPIA Publication 315, March 1980.

5. F. A. Vassallo, "An Evaluation of Heat Transfer and Erosion in the 155mm M185 Cannon," Calspan Technical Report VL-5337-D-1, July 1976.

6. T. L. Brosseau, "An Experimental Method of Accurately Determining the Temperature Distribution and Heat Transferred in Gun Barrels," BRL Report 1740, September 1974. (AD B000171L)

7. F. A. Vassallo, "Thermal and Erosion Phenomenology in Medium-Caliber, Anti-Armor Automatic Cannons (MC-AAAC)," Proceedings of the 1980 JANNAF Propulsion Meeting, CPIA Publication 315, March 1980.

8. "Evaluation of Cannon Tubes," US Army Technical Manual TM-9-1000-202-14, November 1976.

9. J.A. Lannon et al, "Performance of Chromium-Plate in the 105mm M68 Tank Cannon," Report in preparation.

APPENDIX A

TEMPERATURE MEASUREMENTS USED TO COMPUTE TOTAL HEAT INPUTS

APPENDIX A

Temperature Measurements Used to Compute
Total Heat Inputs

ID	ΔT_1	ΔT_2	ΔT_3	ΔT_4	Q,J/mm
29	107.3	*	52.3	27.7	
33	101.6	*	55.6	27.5	
36	104.9	*	53.8	28.0	
37	103.0	78.7	55.2	27.7	
Mean	104.2		54.2	27.7	387.2
55	110.5	81.1	55.8	30.0	
58	109.8	85.0	58.6	31.6	
Mean	110.2	83.0	57.2	30.8	411.5
59	95.8	69.7	46.5	25.7	351.6
60	79.6	59.0	37.2	21.0	290.1
62	73.7	54.6	38.8	19.5	267.9
65	67.8	51.6	34.1	17.9	247.3
66	72.1	50.6	33.3	20.6	260.7
69	68.3	39.2	30.0	17.5	249.9
71	53.7	39.8	26.9	17.7	211.7
72	58.7	34.6	*	17.9	203.4
74	49.3	33.5	*	17.9	186.9
75	51.1	40.8	*	18.3	185.3
76	49.8	45.8	*	15.8	185.3
77	52.1	44.8	*	19.4	193.1
78	61.3	55.0	*	21.3	222.0
79	76.9	61.0	*	20.8	278.8
80	91.1	79.4	*	25.2	351.1
83	97.3	71.5	*	23.5	351.1
84	75.2	58.8	*	20.4	269.0
85	65.0	18.1	*	15.6	235.4
87	62.5	26.5	*	18.1	225.1
90	65.0	32.1	*	18.1	233.9
91	57.7	28.3	*	13.7	207.6
92	62.5	28.8	*	15.6	225.1
93	89.6	60.9	*	25.6	
94	83.6	57.4	*	24.8	
95	85.7	57.1	*	22.5	
Mean	86.3	58.5		284.3	331.0

APPENDIX A CONTINUED

ID	ΔT_1	ΔT_2	ΔT_3	ΔT_4	Q,J/mm
96	100.3	69.1	*	33.1	
97	102.4	72.1	*	33.0	
98	100.2	64.9	*	36.1	
Mean	100.9	70.4		34.1	384.1
99	77.8	56.8	*	48.1	295.8
103	92.2	63.1	*	29.7	361.4
104	101.9	68.5	*	31.1	
105	103.9	69.9	*	32.5	
106	107.7	72.9	*	31.6	
Mean	104.5	70.4		31.7	406.9
107	84.5	54.6	*	26.0	332.0
108	72.8	49.4	*	22.1	277.8
109	78.0	45.5	*	24.7	272.1
110	75.4	40.3	*	18.2	237.5
111	58.5	39.0	*	18.2	210.7
112	58.5	39.0	*	19.5	209.1
113	45.5	35.1	*	14.3	174.5
114	53.3	35.1	*	14.3	179.2
115	54.6	31.2	*	13.0	178.1
122	76.1	*	*	18.0	
123	69.2	18.1	*	16.9	
124	66.9	19.2	*	14.3	
125	67.3	18.0	*	16.4	
126	67.3	18.0	*	20.2	
127	66.9	19.2	*	17.7	
128	66.9	18.0	*	18.2	
Mean	68.7	18.4		17.4	252.0

APPENDIX B

STAR GAUGE MEASUREMENTS FROM 120-MM GUN TUBE RP14

SHEET 1 OF 2

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

120 M/M Tube	DATE OF GAUGING: 29 Nov. 1979
NUMBER: RP14	FIRING STATUS (Check One): BEFORE / AFTER ✓
MODEL: Smooth Bore	NUMBER OF ROUNDS: 24
MANUFACTURER: FOREIGN	PROOF OFFICER: MR. SAUBIER W.O. 300-32038-01
CASTING NUMBER: X	

Rear Face of Breech ✓	Rear Face Of Tube	4.70" Bore Y	4.70" Bore X	[illegible]	
220.00	209.50	+.024	+.025		
219.50	208.00	24	25		
218.50	207.00	24	26		
216.50	205.00	24	26		
211.50	200.00	25	26		
206.50	195.00	25	25		
201.50	190.00	25	25		
196.50	185.00	25	25		
191.50	180.00	25	25		
186.50	175.00	25	25		
181.50	170.00	25	25		
176.50	165.00	25	25		
171.50	160.00	25	25		
166.50	155.00	25	24		
161.50	150.00	24	24		
156.50	145.00	24	24		
151.50	140.00	24	24		
146.50	135.00	24	24		
141.50	130.00	24	24		
136.50	125.00	24	24		
131.50	120.00	24	24		
126.50	115.00	24	24		
121.50	110.00	24	24		
116.50	105.00	24	24		
111.50	100.00	24	24		
106.50	95.00	24	24		
101.50	90.00	24	24		
96.50	85.00	23	23		
91.50	80.00	23	23		
86.50	75.00	23	23		
81.50	70.00	23	23		
76.50	65.00	23	23		
71.50	60.00	23	23		
66.50	55.00	23	23		
61.50	50.00	23	24		
56.50	45.00	23	24		
51.50	40.00	23	24		
46.50	35.00	24	24		
41.50	30.00	24	24		
38.30	26.80	24	24		
37.30	25.80	24	24		
36.30	24.80	24	23		
35.80	24.30	24	23		
35.55	24.05	24	23		
35.40	23.90	+.024	+.024		

180 m/m TUBE ... SMOOTH BORE ... W.O. 300-32038-01

29 Nov. 1979 A.F. 24 RDS.

DISTANCE (Inches) FROM					GAUGE READINGS ARE INDICATED IN ... OF AN INCH					
REAR FACE OF BREECH	MUZZLE FACE	REAR FACE OF TUBE	BASIC DIAMETER	ZERO	GAUGE READING	ACTUAL DIAMETER	DIFFERENCE	GAUGE READING	ACTUAL DIAMETER	DIFFERENCE
[illegible]		[illegible]		4.7[illegible]	+.077	4.777		+.077	4.777	
[illegible]		22.75			78	778		78	778	
[illegible]		[illegible]			78	778		78	778	
33.50		22.00			+.080	4.780		+.080	4.780	
30.50		19.00		6.200"	-.003	6.197		-.004	6.196	
30.00		18.50			1	199		1	199	
29.50		18.00			1	199		1	199	
27.50		16.00			2	198		2	198	
25.50		14.00			2	198		2	198	
23.50		12.00			2	198		1	199	
21.50		10.00			1	199		1	199	
19.50		8.00			1	199		1	199	
17.50		6.00			.000	200		1	199	
15.50		4.00			+.001	201		+.001	201	
14.50		3.00			1	201		.000	200	
14.00		2.50			.000	200		0	200	
13.50		2.00			+.009	209		+.010	210	
13.00		1.50			21	221		22	222	
12.50		1.00			33	233		34	234	
12.25		.75			39	239		39	239	
12.00		.50			45	245		45	245	
11.75		.25			51	251		51	251	
11.60		.10			+.054	6.254		+.054	6.254	

SPECIAL MEASUREMENTS

	BASIC	ACTUAL		BASIC	ACTUAL
TOTAL LENGTH OF GUN	—	220.15"	ROTATION OF TUBE AT BREECH	-----	-----
TOTAL LENGTH OF TUBE	—	20[illegible].62"	MOVEMENT OF TUBE AT BREECH	-----	-----
DEPTH OF BREECH RECESS	—	11.50"	Smooth Bore		

Borescoped: (Chrome Plated Tube) Chrome lightly chipped from rear edge of chamber in the 4:30 to 7:00 o'clock area. Light scratches and stains with moderate to light carbon and other deposits throughout chamber and main bore. Chrome lightly chipped and flaked between 35" and 73" from rear face of tube (RFT) in the 4:00 to 8:00 o'clock area, more pronounced in the 6:00 o'clock area. Chrome chipped and flaked from forward edge of bore evacuator holes, more pronounced on the 12:00 and 4:30 o'clock holes. One chrome chip at muzzle in the 8:00 and 10:00 o'clock area. Photographs taken of bore. No impressions taken at this time.

STAMPED	STARGAUGED AND INSPECTED BY MOODY	REVIEWED BY
RODMAN McWILLIAMS	TIME	COMPILATOR
RECORDER GILLEY	PLACE 525	GRAPHED BY

SHEET 1 OF 3

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

120 MM Tube

NUMBER: RP 14

MODEL: Smooth Bore

MANUFACTURER: FOREIGN

CASTING NUMBER: X

DATE OF GAUGING: 21 APRIL 80

FIRING STATUS (Check One): BEFORE / AFTER X

NUMBER OF ROUNDS: 90

PROOF OFFICER: MR. GEENE

W.O. 300-44027-30

120 MM Smooth Bore

Distances in Inches From		Gauge Meas. Indicated in [illegible] of an Inch			
Rear Face Of Breech	Rear Face Of Tube	4.724" Zero Y	4.724" Zero X	Smooth Bore	
220.00	208.50	+.001	+.001		
219.50	208.00	1	1		
218.50	207.00	1	1		
216.50	205.00	1	2		
211.50	200.00	1	2		
206.50	195.00	1	1		
201.50	190.00	1	1		
196.50	185.00	1	.000		
191.50	180.00	1	0		
186.50	175.00	1	0		
181.50	170.00	1	0		
176.50	165.00	1	0		
171.50	160.00	1	0		
166.50	155.00	1	+.001		
161.50	150.00	1	1		
156.50	145.00	1	1		
151.50	140.00	1	1		
146.50	135.00	1	1		
141.50	130.00	1	1		
136.50	125.00	1	1		
131.50	120.00	1	1		
126.50	115.00	1	.000		
121.50	110.00	1	0		
116.50	105.00	.000	0		
111.50	100.00	0	0		
106.50	95.00	0	0		
101.50	90.00	0	0		
96.50	85.00	-.001	0		
91.50	80.00	1	-.001		
86.50	75.00	1	1		
81.50	70.00	1	1		
76.50	65.00	1	1		
71.50	60.00	1	1		
66.50	55.00	1	1		
61.50	50.00	1	2		
56.50	45.00	2	2		
51.50	40.00	1	2		
46.50	35.00	1	1		
41.50	30.00	.000	.000		
38.30	26.80	0	0		
37.30	25.80	0	0		
36.30	24.80	0	0		
35.80	24.30	0	0		
35.55	24.05	0	0		
35.40	23.90	.000	.000		

120 M/M Smooth Bore								Chamber		
DISTANCE (Inches) FROM					GAUGE MEASUREMENTS INDICATED IN 1/1000 OF AN INCH					
					Y			X		
REAR FACE OF BREECH	MUZZLE FACE	REAR FACE OF TUBE	BASIC DIAMETER	ZERO	GAUGE READING	ACTUAL DIAMETER	DIFFERENCE	GAUGE READING	ACTUAL DIAMETER	DIFFERENCE
34.65		23.15		4.700"	+.077	4.777		+.078	4.778	
34.25		22.75			78	.778		78	.778	
34.00		22.50			78	.778		78	.778	
33.50		22.00			+.079	4.779		+.079	4.779	
30.50		19.00			-.004	6.196		-.004	6.196	
30.00		18.50			2	198		2	198	
29.50		18.00			2	198		3	197	
27.50		16.00			3	197		3	197	
25.50		14.00			3	197		3	197	
23.50		12.00			3	197		3	197	
21.50		10.00			2	198		2	198	
19.50		8.00			2	198		2	198	
17.50		6.00		6.200"	1	199		1	199	
15.50		4.00			.000	6.200		.000	6.200	
14.50		3.00			0	200		0	200	
14.00		2.50			0	200		0	200	
13.50		2.00			+.009	6.209		+.009	6.209	
13.00		1.50			21	221		21	221	
12.50		1.00			33	233		33	233	
12.25		.75			39	239		39	239	
12.00		.50			45	245		45	245	
11.75		.25			51	251		51	251	
11.60		.10			+.054	6.254		+.054	6.254	

21 APRIL 1980 AFTER FIRE 90 Rds.

SPECIAL MEASUREMENTS

	BASIC	ACTUAL		BASIC	ACTUAL
TOTAL LENGTH OF GUN	—	—	ROTATION OF TUBE AT BREECH	—	—
TOTAL LENGTH OF TUBE	—	208.62"	MOVEMENT OF TUBE AT BREECH	—	—
DEPTH OF BREECH RECESS	—	11.50	NUMBER OF LANDS AND GROOVES	—	—
			Smooth Bore	SMOOTH	BORE

W.O. 300-44027-30

STAMPED NOT STAMPED	STARGAUGED AND INSPECTED BY R. GILLEY	REVIEWED BY
RODMAN D. TESCH	TIME	COMPILATOR
RECORDER R. BRANNIGAN	PLACE RANGE #18	GRAPHED BY

Manufacturer	FOREIGN
Model	SMOOTH BORE
Number	RP 14
Size	120 MM TUBE
Proof Officer	MR. GEENE
W.O.	300-440 27-30
Number of Rounds	90
Firing Status (Check one)	After ✓ / Before
Date of Gaging	21 APRIL 80

INSPECTION REMARKS

(PT-IOP 750-1)

Borescoped: (Chrome Plated Tube)

Chrome lightly chipped from rear edge of chamber in the 4:30 to 7:00 o'clock area. Light scratches and stains with moderate to light carbon and other deposits throughout chamber and main bore. Four gage holes drilled through chamber wall (plugged) in the 12:00, 3:00, 6:00 and 9:00 o'clock areas 26.55" from rear face of tube (RFT). Very light heat checking encircling forcing cone and extending forward into main bore to 28" from (RFT). Chrome lightly chipped and flaked from bore between 35" and 55" from (RFT) in the 4:00 to 8:00 o'clock area and encircling bore between 55" and 73" from (RFT) and intermittant throughout remainder of bore. This condition more pronounced in the 6:00 o'clock area and at muzzle. Chrome lightly chipped and flaked from forward and rear edges of 12:00 o'clock bore evacuator holes and from forward edges of remaining holes.

Photographs taken of bore. No impressions taken at this time.

STEAP-MT Form 181, 7 Dec 71 (REPLACES STEAP-DS FORM 181, 17 JUN 64, WHICH MAY BE USED)

MULTIPLE STARGAGE MEASUREMENT & INSPECTION DATA FORM

120 M/M Smooth Bore

120 M/M Tube	NUMBER	MODEL	MANUFACTURER	CASTING NUMBER
	RP14	Smooth Bore	FOREIGN	X

DATE OF GAUGING: 11 July 1980

FIRING STATUS (Check One): BEFORE / AFTER ✓

NUMBER OF ROUNDS: 121

PROOF OFFICER: MR. GREENE
a0.300-44027-30

Distances in inches from Muzzle Face ✓	Rear Face Of Breech	Rear Face Of Tube	Gauge Meas. indicated in 1/1000 of an inch: 4.724" Zero Y	4.724" Zero X	Smooth Bore	
.15	220.00	208.50	.000	+.001		
.65	219.50	208.00	0	1		
1.65	218.50	207.00	0	1		
3.65	216.50	205.00	0	1		
8.65	211.50	200.00	+.001	1		
13.65	206.50	195.00	1	.000		
18.65	201.50	190.00	1	0		
23.65	196.50	185.00	1	0		
28.65	191.50	180.00	1	0		
33.65	186.50	175.00	1	0		
38.65	181.50	170.00	1	0		
43.65	176.50	165.00	1	0		
48.65	171.50	160.00	1	+.001		
53.65	166.50	155.00	1	1		
58.65	161.50	150.00	1	1		
63.65	156.50	145.00	1	1		
68.65	151.50	140.00	1	1		
73.65	146.50	135.00	1	1		
78.65	141.50	130.00	1	1		
83.65	136.50	125.00	1	1		
88.65	131.50	120.00	1	1		
93.65	126.50	115.00	1	1		
98.65	121.50	110.00	1	1		
103.65	116.50	105.00	1	.000		
108.65	111.50	100.00	1	0		
113.65	106.50	95.00	1	0		
118.65	101.50	90.00	1	0		
123.65	96.50	85.00	.000	-.001		
128.65	91.50	80.00	-.001	1		
133.65	86.50	75.00	1	2		
138.65	81.50	70.00	2	2		
143.65	76.50	65.00	3	2		
148.65	71.50	60.00	3	3		
153.65	66.50	55.00	3	3		
158.65	61.50	50.00	3	3		
163.65	56.50	45.00	3	3		
168.65	51.50	40.00	3	3		
173.65	46.50	35.00	4	4		
178.65	41.50	30.00	3	4		
181.85	38.30	26.80	3	3		
182.85	37.30	25.80	3	3		
183.85	36.30	24.80	3	3		
184.35	35.80	24.30	2	3		
184.45	35.55	24.05	2	3		
184.75	35.40	23.90	-.002	-.003		

120 MM Smooth Bore — Chamber

DISTANCE (Inches) FROM					GAUGE MEASUREMENTS INDICATED IN 1/1000 OF AN INCH					
REAR FACE OF BREECH	MUZZLE FACE	REAR FACE OF TUBE	BASIC DIAMETER	ZERO	I GAUGE READING	I ACTUAL DIAMETER	I DIFFERENCE	II GAUGE READING	II ACTUAL DIAMETER	II DIFFERENCE
34.65		23.15		4.700"	+.077	4.777		+.077	4.777	
34.25		22.75			77	.777		77	.777	
34.00		22.50			77	.777		77	.777	
33.50		22.00			+.078	4.778		+.078	4.778	
30.50		19.00		6.200"	-.004	6.196		-.004	6.194	
30.00		18.50			2	.198		2	.198	
29.50		18.00			2	.198		3	.197	
27.50		16.00			3	.197		3	.197	
25.50		14.00			3	.197		3	.197	
23.50		12.00			3	.197		3	.197	
21.50		10.00			2	.198		2	.198	
19.50		8.00			2	.198		2	.198	
17.50		6.00			1	.199		1	.199	
15.50		4.00			.000	6.200		.000	6.200	
14.50		3.00			0	.200		0	.200	
14.00		2.50			0	.200		0	.200	
13.50		2.00			+.009	6.209		+.009	6.209	
13.00		1.50			21	.221		21	.221	
12.50		1.00			33	.233		33	.233	
12.25		.75			39	.239		39	.239	
12.00		.50			45	.245		45	.245	
11.75		.25			51	.251		51	251	
11.60		.10			+.054	6.254		+.054	6.254	

SPECIAL MEASUREMENTS

	BASIC	ACTUAL		BASIC	ACTUAL
TOTAL LENGTH OF GUN	—	—	ROTATION OF TUBE AT BREECH	—	—
TOTAL LENGTH OF TUBE	—	208.62"	MOVEMENT OF TUBE AT BREECH	—	—
DEPTH OF BREECH RECESS	—	11.50	NUMBER OF LANDS AND GROOVES	—	—
			Smooth Bore	SMOOTH BORE	

STAMPED NOT STAMPED	STARGAUGED AND INSPECTED BY V. TESCH	REVIEWED BY
RODMAN McWILLIAMS	TIME	COMPILATOR
RECORDER BRANNIGAN	PLACE RANGE #18	GRAPHED BY

11 July 1980

After Firing 121 Rds.

Smooth bore

Foreign

For: Mr. Greene

W.O.300-44027-30

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